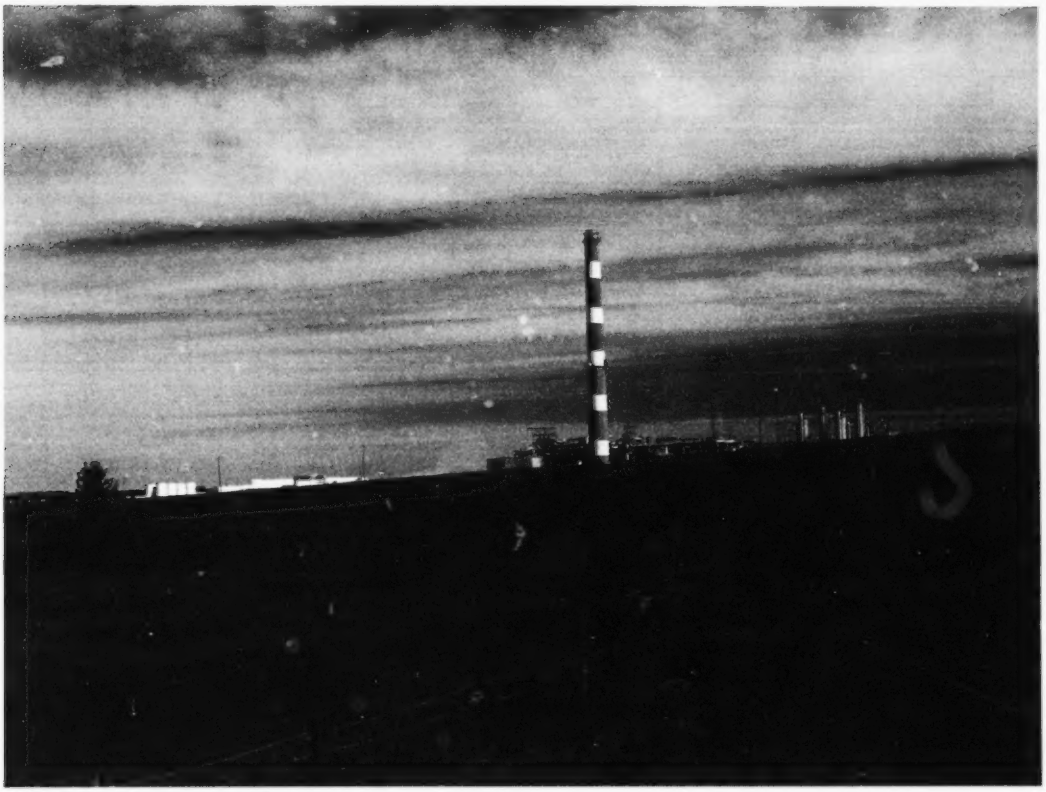
ST101-2007

EUB

Sulphur Recovery and Sulphur Emissions at Alberta Sour Gas Plants

Annual Report

July 2007



Alberta Energy and Utilities Board

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ST101-2007: Sulphur Recovery and Sulphur Emissions at Alberta Sour Gas Plants

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1 Introduction

In *Interim Directive (ID) 2001-03: Sulphur Recovery Guidelines for the Province of Alberta*, the Alberta Energy and Utilities Board (EUB) committed to monitoring the sulphur recovery of grandfathered[1] sour gas plants and publishing an annual summary report on industry performance. This report covers both grandfathered sour gas plants (sulphur recovery and larger acid gas flaring sour gas plants) and nongrandfathered[2] sour gas plants (sulphur recovery and all acid gas injection sour gas plants). A complete list of the grandfathered and nongrandfathered plants is in Appendices 2.1-2.4.

While *ID 2001-03* did not change the recovery levels expected for new gas plants, it set out clear expectations on when older grandfathered plants are required to meet the same requirements as new plants. The ID incorporated a phased approach to the more stringent requirements and encouraged operators of sulphur recovery plants to take early action to improve performance.

Grandfathered sulphur recovery plants that perform better than the minimum requirements specified in *ID 2001-03* have the option to file sulphur emission performance credit report forms and may use the credits to meet a portion of the sulphur recovery requirements at a future date (i.e., operate for a longer time or at a higher inlet rate before having to degrandfather the plant). All grandfathered sulphur recovery plants are now taking advantage of the emission credit program, and credits are continuing to grow every year, as would be expected in these early years when credits are easier to earn.

Acid gas flaring plants have no ability to earn credits and are subject to more stringent requirements over time.

In the last seven years a number of plants have degrandfathered:[3] 14 plants have made upgrades to their plant, 10 plants have been relicensed to meet the requirements for new plants, and 5 plants have ceased operating. There are 31 grandfathered plants remaining. In addition, sulphur emissions have decreased substantially from 2000 to 2006 for both grandfathered acid gas flaring plants (emissions down 66 per cent) and grandfathered sulphur recovery plants (emissions down 27 per cent).

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[1] Grandfathered plants are those that do not meet the sulphur recovery requirements for new plants listed in *ID 2001-03*. This includes some sulphur recovery plants and larger (sulphur inlet greater than 1 tonne per day [t/d]) acid gas flaring plants.

[2] Nongrandfathered plants are those with an approved sulphur inlet greater than 1 t/d meeting the requirements for new plants, as listed in *ID 2001-03*. This includes both sulphur recovery plants and acid gas injection plants.

[3] Degrandfathered plants are those that did not previously meet the requirements of *ID 2001-03* for new plants but have now been relicensed to meet the requirements for new plants, as set out in the ID.

2 Summary of Performance for Grandfathered Plants, 2000-2006

2.1 Grandfathered Plants That Have Been Degrandfathered

In the last seven years, 14 plants have made modifications to improve or install sulphur recovery at their plants to meet the more stringent sulphur recovery requirements for new plants. In addition, 10 other plants have been relicensed to meet these more stringent sulphur recovery requirements, and 5 grandfathered plants have shut down. Further details on these plants are provided in Appendix 1.

Plants that were degrandfathered in 2006 included

1) Kaybob S. 3 – Semcams
2) Swan Hills South (Judy Creek) – Pengrowth
3) Big Bend – CNRL
4) Enchant – Taylor Management

As of December 2006, there are 18 grandfathered sulphur recovery plants and 13 grandfathered acid gas flaring plants remaining (see Appendix 2).

A detailed list of plants that have been degrandfathered in the last seven years is in Appendix 3, along with the process used for improving sulphur recovery.

2.2 Sulphur Emissions and Inlets at Grandfathered Plants, 2000-2006

An analysis of the sulphur emissions and sulphur inlet for the specific plants that were listed in *ID 2001-03* as grandfathered follows in Sections 2.2.1 and 2.2.2. For the purpose of this analysis, plants that have degrandfathered since *ID 2001-03* was issued are included with the grandfathered plants.

2.2.1 Sulphur Emissions Reduction

There have been substantial reductions in sulphur emissions from the grandfathered plants between 2000 and 2006, as shown in Figure 1.

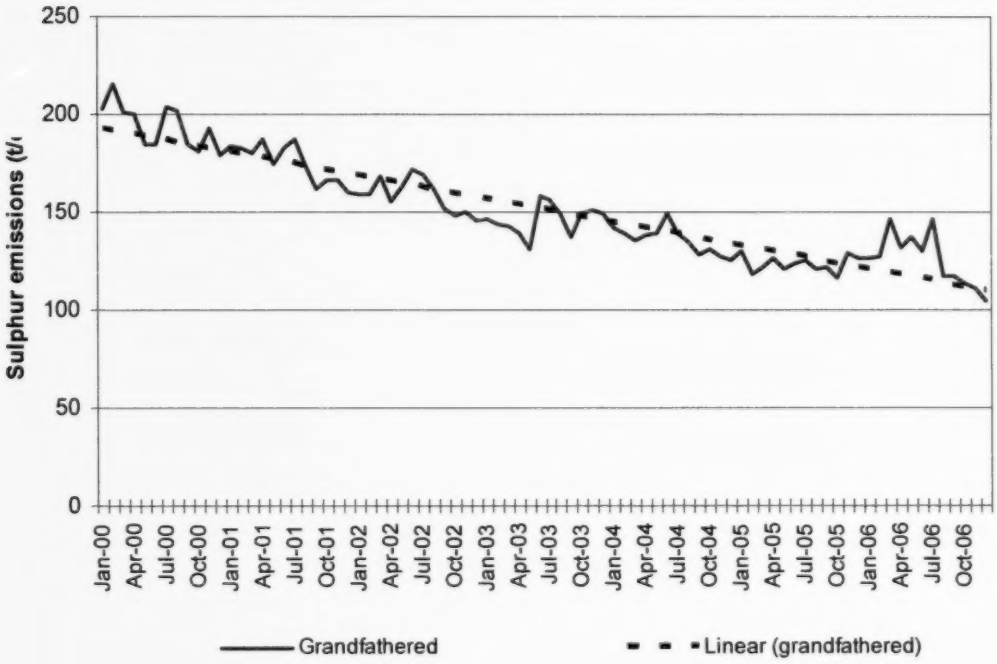

Figure 1. Sulphur emissions from grandfathered plants

The 35 per cent drop in emissions from grandfathered plants from the baseline year of 2000 to 2006, shown in Figure 1, is due to a decrease of about 66 per cent in emissions from the grandfathered acid gas flaring plants and a decrease of about 27 per cent from the grandfathered sulphur recovery plants.

As can be seen in Figure 1, there was a slight increase in emissions (about 2 per cent) from the grandfathered plants from 2005 to 2006. This increase was primarily due to an increase in throughput at one facility, Husky Strachan (Ram River), where a larger increase in sulphur inlet led to an increase in emissions. About half of this increase was offset by a decrease in emissions at the Semcams Kaybob S.3 plant, which made plant modifications and degrandfathered in 2006.

The 66 per cent decrease in emissions from grandfathered acid gas flaring plants from 2000 to 2006 was accompanied by a 19 per cent decrease in sulphur inlet. The decrease in emissions is due in part to the acid gas injection facility installed at Apache Virginia

Hills (Hope Creek), the installation of sulphur recovery at Petro-Canada Wilson Creek, and the installation of acid gas injection at the ConocoPhillips Vulcan (Long Coulee), Harvest Operations Bellshill, and Taylor Retlaw (Turin) facilities. Between 2000 and 2006, 28 of the 28 grandfathered acid gas flaring plants showed emissions reductions.

The 27 per cent decrease in emissions from grandfathered sulphur recovery facilities from 2000 to 2006 was accompanied by a 15 per cent decline in sulphur inlet. The decrease in emissions is due in large part to improved operations at BP Windfall, Semcams Kabob S. 3, Keyera Brazeau, and Shell Jumping Pound. Of the 28 grandfathered sulphur recovery plants, 25 reduced emissions, as shown in Appendix 4.1.

Appendix 4 lists sulphur production and emissions for each of the sulphur recovery plants for the years 2000 and 2006.

2.2.2 Decline in Sulphur Inlet

While improvements in operation and plant modifications have played a significant role in emission reductions at the grandfathered plants, as noted above, the reduction is also due to the declining sulphur inlets of these plants from 2000 to 2006, although in the last year the sulphur inlet increased, as shown in Figure 2.

As can be seen in Figure 2, there was about a 10 per cent increase in sulphur inlet from the grandfathered plants from 2005 to 2006. This was primarily due to an increase in throughput at two facilities, Husky Strachan, (Ram River) and Keyera Strachan, which together increased throughput by about 650 tonnes per day (t/d).

Figure 2 shows the overall decline in sulphur inlets for grandfathered gas plants.

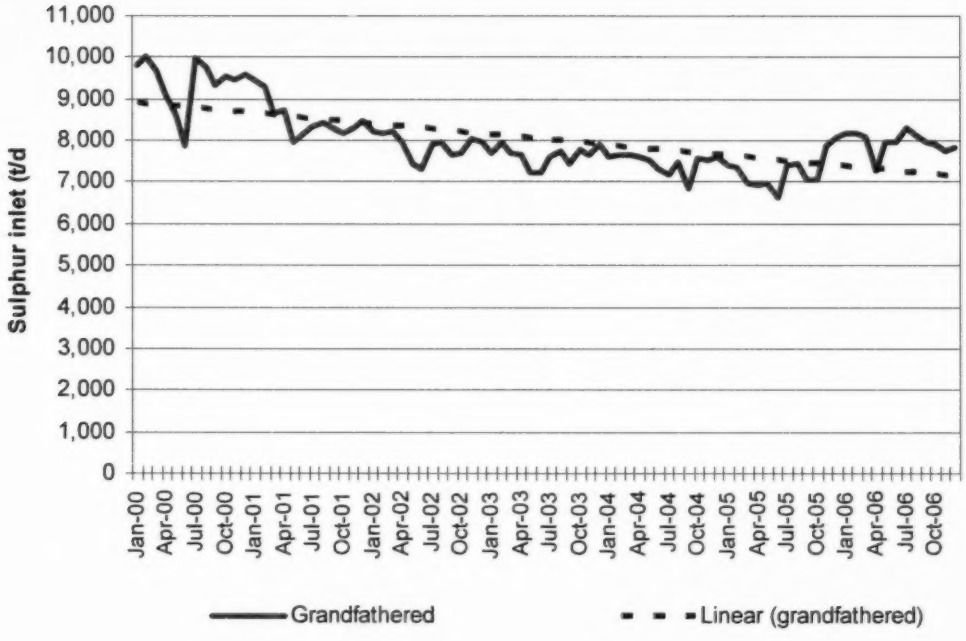

Figure 2. Sulphur inlet for grandfathered plants

2.3 Sulphur Emission Performance Credits (Emission Credits)

Emission credits can be earned by grandfathered sour gas plants with sulphur recovery that achieve recovery efficiencies higher than their required blended sulphur recovery efficiency. Credits cannot be transferred between facilities and do not apply to acid gas flaring plants.

Credit reports can help an operator

- operate at higher sulphur inlets,
- meet the required blended sulphur recovery efficiency, and
- defer upgrading for a longer period of time.

Each sulphur emission credit represents 1 t of sulphur emissions that would have been emitted if the plant exactly met its minimum requirement. Credits must be earned before they can be used.

All plants that are able to file credit reports are doing so, and the emission credits are still growing. As of the end of the fourth quarter of 2006, about 67 000 t of sulphur emission credits had been earned (see Figure 3 and Appendix 5). The total sulphur emissions from grandfathered sulphur recovery plants in 2006 was only 41 000 t. Emission credits as of December 2006 equate to about 20 months of emissions from the grandfathered sulphur recovery plants.

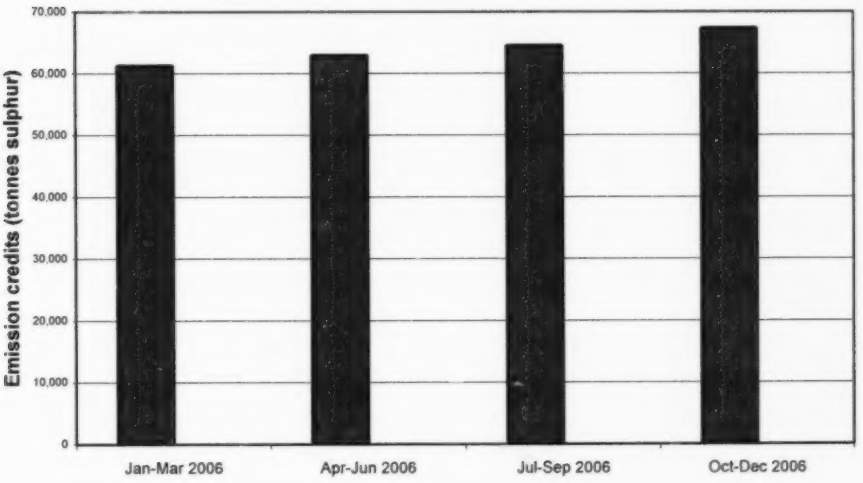

Figure 3. Net sulphur emission credits over time

Appendix 5 lists quarterly credits earned and cumulative credits for each of the grandfathered sulphur recovery plants in 2006.

3 Summary of Performance for Nongrandfathered Plants, 2000-2006

The sulphur emissions and sulphur inlet for the specific sour gas plants (having a sulphur inlet greater than 1 t/d) that met the requirements for new plants when *ID 2001-03* was issued were also examined.

The drop in sulphur emissions from these nongrandfathered plants was about 28 per cent between 2000 and 2006. The reduction in sulphur inlet was about 21 per cent over the same period. Details on these reductions on an individual plant basis for plants with sulphur recovery are given in Appendix 4.

4 Summary of Overall Performance for Grandfathered and Nongrandfathered Plants, 2000-2006

Examining sulphur inlet and sulphur emissions from both the grandfathered acid gas flaring and sulphur recovery facilities and nongrandfathered acid gas injection and sulphur recovery facilities reveals a 34 per cent drop in emissions from 2000 to 2006, together with a reduction in sulphur inlet of 18 per cent. In the last year, from 2005 to 2006, both the emissions and the sulphur inlet drop were about 2 per cent.

Appendix 1 Grandfathered Plants That Have Been Degrandfathered, 2000-2006

In the last seven years, 14 plants have made modifications to improve or install sulphur recovery at their plants to meet the more stringent sulphur recovery requirements for new plants. In addition, 10 other plants have been relicensed to meet these more stringent sulphur recovery requirements, and 5 grandfathered plants have shut down.

The 14 facilities listed below had significant physical modifications to their plants to achieve higher sulphur recoveries.

Plants making modifications to meet the requirements for new plants

Plant name	Operator
1. Brazeau River	Keyera
2. Garrington (Olds)	Esprit
3. Homeglen (Rimbey)	Keyera
4. Bantry	AltaGas
5. Vulcan (Long Coulee)	Conoco Phillips
6. Wilson Creek	Petro-Canada
7. Rainbow	Husky
8. Edson	Talisman
9. Retlaw (Turin)	Taylor Management
10. Virginia Hills	Apache
11. Bellshill	Harvest Operations
12. Simonette	Suncor
13. Swan Hills South (Judy Creek)	Pengrowth (2006 modifications)
14. Kaybob S. 3	Semcams (2006 modifications)

Of the 10 plants listed below, 4 were relicensed to a higher sulphur recovery efficiency with existing equipment and/or minor modifications and 6 were relicensed to a lower throughput without modifications.

Plants relicensing to meet the requirements for new plants

Plant name	Operator
1. Okotoks (Mazeppa)	MPP
2. Crossfield East	Primewest
3. Sylvan Lake	NAL Resources
4. Sturgeon Lake	Kereco
5. Carson Creek	Pengrowth
6. Holmberg (Strome)	CNRL
7. Wilson Creek	Imperial
8. Strachan	Keyera
9. Big Bend	CNRL (2006)
10. Enchant	Taylor Management (2006)

Grandfathered plants that have ceased operating

Plant name	Operator
1. North Rosevear	Suncor
2. Bittern Lake	CNRL
3. North Caroline	BP Canada
4. South Caroline	BP Canada
5. Harmattan - Elkton	Bonavista

A detailed list of plants that have been degrandfathered in the last seven years is in Appendix 3, along with the process used for improving the sulphur recovery.

As of December 2006, there are 18 grandfathered sulphur recovery plants and 13 grandfathered acid gas flaring plants remaining (see Appendix 2.1 and 2.2).

Appendix 2.1. Grandfathered Sulphur Recovery (SR) Gas Plants

		Plant Code	Current Approved Sulphur Recovery Efficiency (%)	Guideline Recovery for Approved Sulphur Inlet (%)	Approved S Inlet (t/d)	Baseline Capacity 1999 S Inlet (t/d)	Change in Status (from *ID 2001-03*)
1	Brazeau R. - Keyera	1108	98.4	98.4	466.00	67.3	Degrandfathered in 2003; became AGI
2	Brazeau R. (Nordegg) - Keyera	1121	93.5	95.9	49.80	38.2	
3	Burnt Timber - Shell	1131	96.5	98.4	560.00	412.4	
4	Caroline (North) 1-11 - BP Canada	1374	69.7	69.7	5.00	5.0	Plant shut down in 2003
5	Caroline (South) 4-20 - BP Canada	1104	85.0	89.7	9.83	6.8	Plant shut down in 2003
6	Carstairs - Bonavista	1020	90.0	98.2	72.2*	9.5	
7	Crossfield (Balzac) - Nexen	1050	98.0	98.5	1,730.10	414.6	
8	Edson - Talisman	1084	98.4	98.4	350.00	220.9	Degrandfathered in 2003; upgraded SR
9	Gold Creek - CNRL	1129	97.0	98.3	100.00	64.1	
10	Jumping Pound - Shell	1037	96.2	98.4	619.00	472.1	
11	Kaybob S. 1 & 2 - Cams Midstream Services	1107	98.4	98.5	1,107.70	540.6	
12	Kaybob S. 3 - Semcams	1144	98.5	98.5	1,999.90	1,009.6	Degrandfathered in 2006, upgraded SR
13	Lone Pine Ck. - ExxonMobil	1139	98.0	98.3	165.40	129.5	
14	Minnehik B. L. - Penn West	1047	95.6	95.9	49.17	22.0	
15	Okotoks (Mazeppa) - MPP	1530	98.4	98.4	586.60	263.4	Degrandfathered in 2002
16	Redwater - ARC Resources	1028	Fluctuating	95.9	12.2*	3.1	
17	Rosevear (North) - Suncor	1206					Plant shut down in 2001
18	Rosevear (South) - Suncor	1268	95.6	98.3	171.00	76.0	Plant consolidation 1206
19	Simonette - Suncor	1113	95.9	95.9	50.00	92.3	Degrandfathered in 2005, upgraded SR
20	Strachan (Ram River) - Husky	1141	98.1	99.5	4,660.5*	2,301.8	
21	Strachan - Keyera	1133	98.4	98.4	971.10	264.9	Degrandfathered in 2005
22	Sturgeon Lk. - Kereco	1112	95.9	95.9	49.81	40.6	Degrandfathered in 2005
23	Teepee -Talisman	1296	92.0	95.9	25.00	17.5	
24	Waterton - Shell	1056	98.7	99.5	3,148.00	2,099.6	
25	Wildcat Hills - Petro-Canada	1054	97.5	98.3	287.50	181.3	
26	Wimborne - Vault	1081	95.5	98.3	235.00	182.1	
27	Windfall (West Whitecourt) - Semcams	1034	98.3	98.5	1,356.10	777.6	
28	Zama - Apache[1]	1219	92.0	98.2	80.30	38.6	Baseline revision 2001

* Annual average sulphur inlet.

[1] As of October 2004, Zama has been delivering acid gas to its Apache Zama AGI plant.

Appendix 2.2. Grandfathered Acid Gas Flaring Plants

		Plant Code	Guideline Recovery for Approved Sulphur Inlet (%)	2006 S Emissions (t/d)	Approved S Inlet (t/d)	Baseline Capacity 1999 S Inlet (t/d)	Change in Status (from *ID 2001-03*)
1	Ansell (Galloway) - CNRL	1417	69.7	0.25	1.40	1.3	
2	Bantry - AltaGas	1114	69.7	0.34	2.00	1.0	Degrandfathered in 2002; became SR
3	Bellshill Lake - Harvest Operations	1280	89.7	0.06	5.77	3.8	Degrandfathered in 2005; became AGI
4	Big Bend - CNRL	1293	0	0.03	0.67	1.0	Degrandfathered in 2006
5	Bigoray - Penn West	1138	69.7	0.61	1.70	1.8	
6	Bittern Lake - CNRL	1124	69.7		2.48	1.0	Plant shut down in 2000
7	Boundary Lake S - Penn West	1202	69.7	0.82	1.63	1.1	
8	Boundary Lake S - Talisman	1024	69.7	0.45	1.90	1.0	
9	Carson Creek - Pengrowth	1062	0	0.22	0.83	1.0	Degrandfathered in 2004
10	Enchant - Taylor Management	1039	0	0.48	0.99	1.0	Degrandfathered in 2006
11	Forestburg - Signalta	1365	69.7	1.44	4.50	4.0	
12	Greencourt - CNRL	1127	69.7	0.80	1.00	1.3	
13	Harmattan-Elkton - Bonavista	1083	0		0.53	1.0	Degrandfathered in 2005*
14	Holmberg (Strome) - CNRL	1179	0	0.24	0.61	1.6	Degrandfathered in 2005
15	Kaybob - Trilogy	1058	89.7	0.80	5.15	1.0	
16	Killam (Sedgewick) - AltaGas	1510	69.7	1.31	4.75	2.2	
17	Leduc - Woodbend - Imperial	1023	69.7	0.01	1.01	1.0	
18	Little Bow (Travers) - Bonavista	1150	69.7	0.67	1.50	1.2	
19	Retlaw (Turin) - Taylor Management	1191	69.7	0.04	4.64	1.7	Degrandfathered in 2004; became AGI
20	Spirit River - Bonavista	1560	69.7	0.57	2.60	1.0	
21	Swan Hills South (Judy Creek) - Pengrowth	1069	69.7	1.75	3.75	2.7	Degrandfathered in 2006; became AGI
22	Sylvan Lake - NAL Resources	1070	0	0.21	0.75	1.0	Degrandfathered in 2002
23	Virginia Hills (Hope Creek) - Apache	1135	95.9	0.07	16.00	5.2	Degrandfathered in 2004; became AGI
24	Vulcan (Long Coulee) - ConocoPhillips	1100	69.7	0.13	4.90	2.7	Degrandfathered in 2002; became AGI
25	West Drumheller -Canetic	1109	69.7	0.00	2.99	1.1	
26	Whitecourt - Shiningbank	1115	89.7	2.03	7.50	3.5	
27	Wilson Creek - Imperial	1399	0	0.12	0.95	1.0	Degrandfathered in 2005
28	Wilson Creek - Petro-Canada	1096	85.0	0.14	4.70	2.3	Degrandfathered in 2001; became SR

* Harmattan-Elkton plant is now a dehydration and compressor unit.

Appendix 2.3. Nongrandfathered Sulphur Recovery Plants

		Plant Code	Current Approved Sulphur Recovery Efficiency (%)	Approved S Inlet (t/d)
1	Basing (Hanlan Robb) - Petro-Canada	1360	98.5	1,270.00
2	Bonnie Glen - Imperial	1045	89.7	10.00
3	Brazeau R. - Blaze	1482	98.4	500.00
4	Brazeau R. (West Pembina) - ATCO Midstream	1458	98.4	520.00
5	Campbell-Namao (Carbondale) - ATCO Midstream	1638	69.7	1.15*
6	Caroline - Shell	1662	99.5	5,450.00
7	Crossfield E. - Primewest	1079	98.4	863.82
8	Garrington (Olds) - Esprit	1021	98.4	404.90
9	Harmattan - Taylor Processing	1060	98.3	82.70
10	Hays - CNRL	1585	90.0	9.90
11	Homeglen Rimbey - Keyera	1004	98.3	150.00
12	LaGlace (Saddle Hills) - EnCana	1892	98.4	483.10
13	Nevis - Spectra Energy Midstream	1002	98.4	300.00
14	Progress - CNRL	1506	96.5	49.50
15	Progress - Suncor	1629	69.7	2.51
16	Quirk Ck. - Imperial	1134	98.3	306.4*
17	Rainbow - AltaGas	1658	95.9	23.18
18	Rainbow - Husky[1]	1105	98.3	213.49
19	Savanna Ck. (Coleman) - Devon	1051	98.6	800.00
20	Sinclair (Hythe Brainard) - EnCana	1147	98.3	132.20
21	Swalwell - Pioneer[2]	1654	69.7	4.60

* Annual average sulphur inlet.

[1] Husky Rainbow started as an AGI facility in January 2002.

[2] Pioneer Swalwell started as an AGI facility in August 2005.

Appendix 2.4. Nongrandfathered Acid Gas Injection Plants Processing > 1t/d of Sulphur						
			Sulphur Recovery Equivalent	Approved	2006	2006 Sulphur
		Plant	Required	S Inlet	S Emissions	Injected
	Nongrandfathered acid gas injection plants	Code	(%)	(t/d)	(t/d)	(t/d)
1	Acheson -Canetic	1628	69.7	4.65	0.03	2.20
2	Bistcho Lk - Paramount	1975	95.9	25.00	0.19	13.30
3	Bigoray - Keyera	1357	98.2	64.00	0.26	30.49
4	Boundary Lk S (Clear Hills) - CNRL	1880	95.9	19.21	0.00	12.65
5	Dizzy (Steen River) - Caribou	1738	95.9	34.40	0.01	2.14
6	Dunvegan - Devon	1169	89.7	9.90	0.00	0.43
7	Eaglesham (West Culp) - Devon	1775	95.9	17.20	0.00	0.64
8	Galahad - Husky	1690	89.7	7.54	0.01	2.45
9	Golden Spike - ATCO Midstream	1547	95.9	26.46	0.02	3.38
10	Gordondale - Spectra Energy Midstream	1668	98.2	54.31	0.01	26.16
11	Kelsey (Rosalind) - Thunder	1244	69.7	3.07	0.02	1.04
12	Leduc-Woodbend (Calmar) - Mec Operating Co.	1676	95.9	15.54	0.01	3.49
13	Marlowe (Dizzy) - Bearspaw	1765	95.9	20.90	0.00	0.47
14	Mitsue - Canetic[1]	1123	69.7	4.60	0.00	0.15
15	Mulligan (Fourth Creek) - Spectra Energy Midstream	1895	89.7	10.00	0.05	5.78
16	Normandville - Devon	1990	69.7	1.90	0.00	0.16
17	O'Chiese - Burlington	1970	95.9	14.53	0.01	0.63
18	Paddle River - Keyera	1089	69.7	1.50	0.00	0.57
19	Pembina - Keyera	1402	95.9	29.70*	0.03	11.92
20	Pembina - Imperial	1625	89.7	7.23	0.08	2.47
21	Pouce Coupe - Spectra Energy Midstream	1746	95.9	26.18	0.10	13.63
22	Provost (Hansman Lk) - Husky	1698	89.7	6.90	0.00	5.52
23	Provost (Thompson Lk) - Husky	1695	95.9	12.00	0.04	5.26
24	Puskwaskau - Devon	1964	89.7	5.15	0.00	0.13
25	Rainbow - ExxonMobil	1155	95.9	20.10*	0.04	9.02
26	Rycroft - Birchcliff	1793	95.9	21.00	0.01	3.94
27	Watelet (Glen Park) - ATCO Midstream	1672	69.7	3.30	0.00	0.61
28	Wayne-Rosedale - EnCana	1888	89.7	5.90*	0.07	1.21
29	Wembley - ConocoPhillips	1520	98.3	124.00	0.01	69.55
30	Zama - Apache	1878&1978	98.3	247.00	0.28	43.47
[1] Previously a nongrandfathered acid gas flaring plant that had emissions of less than 1 t/d and is now an AGI facility.						
	Grandfathered and nongrandfathered sulphur recovery or acid gas flaring plants that are now AGI facilities					
31	Bellshill Lake - Harvest Operations	1280	89.7	5.77	0.06	4.10
32	Brazeau R. - Keyera	1108	98.4	466.00	0.31	157.68
33	Rainbow - Husky	1105	98.3	213.49	0.74	123.42
34	Retlaw (Turin) - Taylor Management	1191	69.7	4.64	0.04	1.83
35	Swan Hills South (Judy Creek) - Pengrowth	1069	69.7	3.75	1.75	0.24
36	Virginia Hills (Hope Creek) - Apache	1135	95.9	16.00	0.07	9.38
37	Vulcan(Long Coulee) - ConocoPhillips	1100	69.7	4.90	0.13	1.79
38	Swalwell - Pioneer	1654	69.7	4.60	0.02	0.82
* Annual average sulphur inlet.						

Appendix 3. Plants That Have Been Degrandfathered

				Approved S Inlet	Modification
Plants that have made modifications		**Plant Code**	**Plant Name**	**(t/d)**	**Process**
1	Plant Mods	1108	Brazeau R. - Keyera	400.00	(AGI)
2	Plant Mods	1021	Garrington (Olds) - Esprit	404.90	(SuperClaus)
3	Plant Mods	1004	Homeglen Rimbey - Keyera	150.00	(SuperClaus)
4	Plant Mods	1114	Bantry - AltaGas	2.00	(Xergy)
5	Plant Mods	1100	Vulcan (Long Coulee) - ConocoPhillips	4.90	(AGI)
6	Plant Mods	1096	Wilson Creek - Petro-Canada	4.70	(Claus)
7	Plant Mods	1105	Rainbow - Husky	213.50	(AGI)
8	Plant Mods	1084	Edson - Talisman	350.00	(SuperClaus)
9	Plant Mods	1191	Retlaw (Turin) - Taylor Management	4.64	(AGI)
10	Plant Mods	1135	Virginia Hills - Apache	16.00	(AGI)
11	Plant Mods	1280	Bellshill - Harvest Operations	5.77	(AGI)
12	Plant Mods	1113	Simonette - Suncor	120.00	(SuperClaus)
13	Plant Mods	1069	Swan Hills South (Judy Creek) - Pengrowth	3.75	(AGI)
14	Plant Mods	1144	Kaybob S. 3 - Semcams	1999.00	(SuperClaus)
Plants that have been relicensed to higher sulphur recovery efficiency or lower sulphur inlets					
1	Relicensed	1530	Okotoks (Mazeppa) - MPP	586.60	
2	Relicensed	1079	Crossfield E. - Primewest	863.82	
3	Relicensed	1070	Sylvan Lake - NAL Resources	0.75	
4	Relicensed	1112	Sturgeon Lake - Kereco	49.81	
5	Relicensed	1062	Carson Creek - Pengrowth	0.83	
6	Relicensed	1179	Holmberg (Strome) - CNRL	0.61	
7	Relicensed	1399	Wilson Creek - Imperial	0.95	
8	Relicensed	1133	Strachan - Keyera	971.10	
9	Relicensed	1293	Big Bend - CNRL	0.67	
10	Relicensed	1039	Enchant - Taylor Management	0.99	

Appendix 4.1. Gas Plants with Sulphur Recovery, Year 2006 Minus Year 2000

	Plant Code	Field-Licensee	Change in production and emissions year 2006 minus year 2000 2006-2000 S Production (t/y)	2006-2000 S Emissions (t/y)
Grandfathered plants (in 2001)				
1	1034	Windfall (West Whitecourt) - Semcams	(175,060.3)	(3,204.3)
2	1144	Kaybob S. 3 - Semcams	(56,638.6)	(3,078.8)
3	1108	Brazeau R. - Keyera	(35,158.5)	(2,038.7)
4	1037	Jumping Pound - Shell	44,625.8	(1,744.5)
5	1107	Kaybob S. 1 & 2 - Cams Midstream Services	(142,602.1)	(1,324.3)
6	1056	Waterton - Shell	(152,189.9)	(1,001.9)
7	1081	Wimborne - Vault	(25,583.7)	(763.8)
8	1131	Burnt Timber - Shell	(25,099.7)	(722.0)
9	1206	Rosevear (North) - Suncor	(12,290.7)	(499.6)
10	1113	Simonette - Suncor	(17,417.4)	(480.2)
11	1219	Zama - Apache	(13,434.2)	(472.4)
12	1054	Wildcat Hills - Petro-Canada	(11,480.2)	(391.5)
13	1104	Caroline (South) 4-20 - BP Canada	(2,186.0)	(349.5)
14	1084	Edson - Talisman	8,951.7	(345.9)
15	1121	Brazeau R. (Nordegg) - Keyera	(6,311.7)	(315.0)
16	1050	Crossfield (Balzac) - Nexen	(33,565.9)	(279.6)
17	1112	Sturgeon Lk. - Kereco	(4,979.2)	(267.6)
18	1129	Gold Creek - CNRL	(11,136.5)	(243.7)
19	1133	Strachan - Keyera	22,023.9	(182.2)
20	1047	Minnehik B. L. - Penn West	(4,310.5)	(173.2)
21	1296	Teepee - Talisman	277.0	(118.0)
22	1020	Carstairs - Bonavista	(1,253.4)	(105.1)
23	1374	Caroline (North) 1-11 - BP Canada	(903.1)	(86.8)
24	1530	Okotoks (Mazeppa) - MPP	(7,271.2)	(72.2)
25	1139	Lone Pine Ck. - ExxonMobil	(9,434.5)	(69.9)
26	1028	Redwater - ARC Resources	(408.1)	21.7
27	1268	Rosevear (South) - Suncor	(4,359.1)	95.3
28	1141	Strachan (Ram River) - Husky	62,068.1	2,799.2
	Totals		**(615,127.9)**	**(15,414.4)**
Grandfathered plants that were previously acid gas flaring and are now sulphur recovery				
1	1096	Wilson Creek - Petro-Canada	434.0	(985.6)
2	1114	Bantry - AltaGas	252.8	(187.6)
			686.8	**(1,173.2)**
New suphur recovery plant (new S recovery gas plants or plants previously licensed for less than 1 t S inlet /d)				
			-	-
Nongrandfathered plants (plants meeting the requirements for new plants)				
1	1079	Crossfield E. - Primewest	(86,714.4)	(1,751.2)
2	1004	Homeglen Rimbey - Keyera	(6,070.1)	(918.2)
3	1021	Garrington (Olds) - Esprit	1,909.6	(855.4)
4	1105	Rainbow - Husky	(22,351.5)	(852.4)
5	1662	Caroline - Shell	(593,283.0)	(806.3)
6	1360	Basing (Hanlan Robb) - Petro-Canada	(55,276.6)	(726.8)
7	1458	Brazeau R. (West Pembina) - ATCO Midstream	(2,772.2)	(383.8)
8	1002	Nevis - Spectra Energy Midstream	(17,959.6)	(237.2)
9	1654	Swalwell - Pioneer	(533.4)	(130.7)
10	1060	Harmattan - Taylor Processing	(5,675.7)	(83.3)
11	1585	Hays - CNRL	(488.7)	(81.7)
12	1045	Bonnie Glen - Imperial	(26.7)	(23.8)
13	1638	Campbell-Namao (Carbondale) - ATCO Midstream	(310.5)	(0.2)
14	1629	Progress - Suncor	75.3	-
15	1051	Savanna Ck. (Coleman) - Devon	5,230.1	3.7
16	1658	Rainbow - AltaGas	3,454.7	51.7
17	1506	Progress - CNRL	1,979.6	80.4
18	1147	Sinclair (Hythe Brainard) - EnCana	6,735.7	126.6
19	1134	Quirk Ck. - Imperial	7,198.8	198.5
20	1892	La Glace (Saddle Hills) - EnCana	(9,411.6)	322.7
21	1482	Brazeau R. - Blaze	37,038.1	482.7
	Totals		**(737,252.1)**	**(5,584.6)**
		Grand totals	**(1,351,693.2)**	**(22,172.2)**

Appendix 4.2. Gas Plants with Sulphur Recovery, Year 2000

	Plant Code	Field-Licensee	Total Inlet (t/y)	Total Annual Emissions (t/y)	Actual Sulphur Recovery Effic. (%)	Current Approved Sulphur Recovery Effic. (%)	Total Annual Production (t/y)
Grandfathered plants (in 2001)							
1	1034	Windfall (West Whitecourt) - Semcams	286,311.3	4,616.6	98.4%	98.3	292,237.0
2	1144	Kaybob S. 3 - Semcams	360,565.8	6,646.1	98.2%	98.1	369,708.4
3	1108	Brazeau R. - Keyera	36,697.0	2,152.6	94.2%	92.1	35,158.5
4	1037	Jumping Pound - Shell	161,744.1	5,509.7	96.6%	96.2	158,522.1
5	1107	Kaybob S. 1 & 2 - Cams Midstream Services	234,341.8	2,756.9	98.9%	98.4	250,134.3
6	1056	Waterton - Shell	671,377.4	6,233.1	99.1%	98.7	679,224.2
7	1081	Wimborne - Vault	57,618.0	1,833.9	96.7%	95.5	54,008.0
8	1131	Burnt Timber - Shell	156,959.7	4,844.0	96.9%	96.5	152,115.5
9	1206	Rosevear (North) - Suncor	10,771.6	499.6	96.1%	94.6	12,290.7
10	1113	Simonette - Suncor	32,358.2	793.8	97.5%	96.5	31,239.2
11	1219	Zama - Apache	15,117.5	583.9	96.1%	92.0	14,405.1
12	1054	Wildcat Hills - Petro-Canada	71,413.7	1,220.0	98.2%	97.5	66,931.2
13	1104	Caroline (South) 4-20 - BP Canada	2,483.7	349.5	86.2%	85.0	2,186.0
14	1084	Edson - Talisman	73,009.3	1,421.2	98.1%	97.9	73,337.4
15	1121	Brazeau R. (Nordegg) - Keyera	12,991.3	727.9	94.6%	93.5	12,842.1
16	1050	Crossfield (Balzac) - Nexen	144,323.2	2,408.8	98.3%	98.0	141,245.3
17	1112	Sturgeon Lk. - Kereco	18,698.9	729.2	96.2%	94.0	18,456.1
18	1129	Gold Creek - CNRL	20,071.4	514.9	97.6%	97.0	20,883.0
19	1133	Strachan - Keyera	97,769.5	1,169.6	98.8%	98.1	97,129.6
20	1047	Minnehik B. L. - Penn West	7,018.8	270.4	96.1%	95.6	6,748.4
21	1296	Teepee - Talisman	5,424.7	372.2	93.2%	92.0	5,070.9
22	1020	Carstairs - Bonavista	3,815.5	324.6	91.2%	90.0	3,370.0
23	1374	Caroline (North) 1-11 - BP Canada	1,039.2	86.8	91.2%	89.7	903.1
24	1530	Okotoks (Mazeppa) - MPP	95,120.2	1,260.7	98.7%	98.3	95,760.9
25	1139	Lone Pine Ck. - ExxonMobil	38,390.2	599.7	98.4%	98.0	37,232.3
26	1028	Redwater - ARC Resources	1,184.9	88.3	92.7%	Fluctuating	1,118.3
27	1268	Rosevear (South) - Suncor	16,104.4	457.5	97.6%	95.6	18,426.7
28	1141	Strachan (Ram River) - Husky	791,052.9	7,877.7	99.0%	98.1	781,009.3
	Totals		**3,423,774.2**	**56,349.2**	**98.4%**		**3,431,693.7**
Grandfathered plants that were previously acid gas flaring and are now sulphur recovery							
1	1096	Wilson Creek - Petro-Canada	908.0	1,036.4	0.0%	-	-
2	1114	Bantry - AltaGas	310.6	310.7	0.0%	-	-
			1,218.5	**1,347.1**	**0.0%**		-
Plants that were previously acid gas flaring that had emissions of less than 1 t/d and are now sulphur recovery							
			-	-	-		-
Nongrandfathered plants (plants meeting the requirements for new plants)							
1	1079	Crossfield E. - Primewest	170,668.1	3,028.6	98.2%	98.0	169,921.2
2	1004	Homeglen Rimbey - Keyera	19,957.4	1,003.0	94.8%	92.0	18,208.7
3	1021	Garrington (Olds) - Esprit	103,220.0	2,152.2	97.9%	97.1	101,783.0
4	1105	Rainbow - Husky	25,910.0	1,123.5	95.2%	95.0	22,351.5
5	1662	Caroline - Shell	1,833,270.9	2,458.5	99.9%	99.8	1,844,827.3
6	1360	Basing (Hanlan Robb) - Petro-Canada	299,824.2	3,434.8	98.8%	98.5	288,911.9
7	1458	Brazeau R. (West Pembina) - ATCO Midstream	107,983.1	1,624.1	98.6%	98.4	112,615.2
8	1002	Nevis - Spectra Energy Midstream	37,590.7	467.5	98.8%	98.4	37,091.8
9	1654	Swalwell - Pioneer	517.6	138.9	79.3%	70.0	533.4
10	1060	Harmattan - Taylor Processing	11,515.1	164.6	98.6%	98.6	11,875.6
11	1585	Hays - CNRL	2,390.2	129.0	94.5%	90.0	2,217.5
12	1045	Bonnie Glen - Imperial	3,281.6	125.8	96.1%	95.9	3,062.0
13	1638	Campbell-Namao (Carbondale) - ATCO Midstream	364.59	0.2	100.0%	69.7	403.7
14	1629	Progress - Suncor	389.10	-	100.0%	69.7	336.7
15	1051	Savanna Ck. (Coleman) - Devon	137,197.0	1,369.9	99.0%	98.6	136,352.7
16	1658	Rainbow - AltaGas	1,882.0	127.9	92.6%	70.0	1,597.4
17	1506	Progress - CNRL	9,215.7	237.8	97.4%	96.5	9,060.8
18	1147	Sinclair (Hythe Brainard) - EnCana	28,431.8	296.2	99.0%	98.3	28,291.8
19	1134	Quirk Ck. - Imperial	86,771.0	1,002.1	98.9%	98.3	90,372.6
20	1892	LaGlace (Saddle Hills) - EnCana	125,906.9	1,292.3	99.0%	98.4	126,382.7
21	1482	Brazeau R. - Blaze	97,601.0	917.1	99.1%	98.4	96,505.4
	Totals		**3,103,888.0**	**21,094.0**	**99.3%**		**3,102,702.9**
		Grand totals	**6,528,880.7**	**78,790.3**	**98.8%**		**6,534,396.6**

Appendix 4.3. Gas Plants with Sulphur Recovery, Year 2006

	Plant Code	Field-Licensee	Total Inlet (t/y)	Total Annual Emissions (t/y)	Annual Sulphur Recovery (%)	Current Approved Sulphur Recovery Effic. (%)	Total Actual Production (t/y)
Grandfathered plants (in 2001)							
1	1034	Windfall (West Whitecourt) - Semcams	118,071.5	1,412.3	98.8%	98.3%	117,176.7
2	1144	Kaybob S. 3 - Semcams	297,970.4	3,567.3	98.9%	98.1%	313,069.8
3	1108	Brazeau R. - Keyera	59,404.7	113.9	99.8%	98.4%	Injected (57,552.1)
4	1037	Jumping Pound - Shell	205,577.2	3,765.2	98.2%	96.2%	203,147.9
5	1107	Kaybob S. 1 & 2 - Cams Midstream Services	111,307.5	1,432.6	98.7%	98.4%	107,532.2
6	1056	Waterton - Shell	522,337.2	5,231.3	99.0%	98.7%	527,034.3
7	1081	Wimborne - Vault	29,287.8	1,070.2	96.4%	95.5%	28,424.4
8	1131	Burnt Timber - Shell	129,528.3	4,122.0	96.9%	96.5%	127,015.8
9	1206	Rosevear (North) - Suncor	-	-	0.0%	0.0%	-
10	1113	Simonette - Suncor	14,117.1	313.6	97.8%	95.9%	13,821.8
11	1219	Zama - Apache*	6,396.8	111.5	98.3%	92.0%	971.0
12	1054	Wildcat Hills - Petro-Canada	57,197.8	828.5	98.5%	97.5%	55,451.0
13	1104	Caroline (South) 4-20 - BP Canada	-	-	0.0%	85.0%	-
14	1084	Edson - Talisman	84,725.8	1,075.3	98.7%	98.4%	82,289.1
15	1121	Brazeau R. (Nordegg) - Keyera	6,962.8	412.9	94.1%	93.5%	6,530.4
16	1050	Crossfield (Balzac) - Nexen	110,971.7	2,129.2	98.1%	98.0%	107,679.4
17	1112	Sturgeon Lk. - Kereco	13,907.2	461.6	96.7%	95.9%	13,476.9
18	1129	Gold Creek - CNRL	10,096.1	271.2	97.3%	97.0%	9,746.5
19	1133	Strachan - Keyera	123,110.2	987.4	99.2%	98.4%	119,153.5
20	1047	Minnehik B. L. - Penn West	2,500.7	97.2	96.2%	95.6%	2,437.9
21	1296	Teepee - Talisman	5,403.5	254.2	95.5%	92.0%	5,347.9
22	1020	Carstairs - Bonavista	2,319.1	219.5	90.6%	90.0%	2,116.6
23	1374	Caroline (North) 1-11 - BP Canada	-	-	0.0%	69.7%	-
24	1530	Okotoks (Mazeppa) - MPP	88,860.6	1,188.5	98.7%	98.4%	88,489.7
25	1139	Lone Pine Ck. - ExxonMobil	27,653.9	529.8	98.1%	98.0%	27,797.8
26	1028	Redwater - ARC Resources	784.8	110.0	86.6%	Fluctuating	710.2
27	1268	Rosevear (South) - Suncor	14,598.3	552.8	96.2%	98.3%	14,067.6
28	1141	Strachan (Ram River) - Husky	852,041.7	10,676.9	98.7%	98.1%	843,077.4
	Totals		**2,895,132.67**	**40,934.80**	**98.6%**		**2,816,565.74**
* Operated as a sulphur recovery plant for two months. Otherwise operated as an acid gas injection plant, delivering 5,633.2 t of acid gas to Apache Zama injection facility.							
Grandfathered plants that were previously acid gas flaring and are now sulphur recovery							
1	1096	Wilson Creek - Petro-Canada	511.0	50.8	89.5%	85.0%	434.0
2	1114	Bantry - AltaGas	469.8	123.1	67.3%	69.7%	252.8
			980.8	**173.9**	**79.8%**		**686.8**
Plants that were previously acid gas flaring that had emissions of less than 1 t/d and are now sulphur recovery							
			-	-	-		-
Nongrandfathered plants (plants meeting the requirements for new plants in 2001)							
1	1079	Crossfield E. - Primewest	87,207.9	1,277.4	98.5%	98.4%	83,206.8
2	1004	Homeglen Rimbey - Keyera	12,529.9	84.8	99.3%	98.3%	12,138.6
3	1021	Garrington (Olds) - Esprit	102,454.0	1,296.8	98.8%	98.4%	103,692.6
4	1105	Rainbow - Husky	41,042.7	271.1	99.4%	98.3%	Injected (45,048.1)
5	1662	Caroline - Shell	1,257,248.1	1,652.2	99.9%	99.5%	1,251,544.3
6	1360	Basing (Hanlan Robb) - Petro-Canada	235,388.2	2,708.0	98.9%	98.5%	233,635.3
7	1458	Brazeau R. (West Pembina) - ATCO Midstream	112,083.4	1,240.3	98.9%	98.4%	109,843.0
8	1002	Nevis - Spectra Energy Midstream	17,119.7	230.3	98.8%	98.4%	19,132.2
9	1654	Swalwell - Pioneer	308.9	8.2	71.3%	70.0%	Injected (300.7)
10	1060	Harmattan - Taylor Processing	6,022.5	81.3	98.7%	98.6%	6,199.9
11	1585	Hays - CNRL	1,813.2	47.3	97.3%	90.0%	1,728.8
12	1045	Bonnie Glen - Imperial	2,934.7	102.0	96.7%	95.9%	3,035.3
13	1638	Campbell-Namao (Carbondale) - ATCO Midstream	92.5	-	100.0%	69.7%	93.2
14	1629	Progress - Suncor	440.3	-	100.0%	69.7%	412.0
15	1051	Savanna Ck. (Coleman) - Devon	142,305.0	1,373.6	99.0%	98.6%	141,582.8
16	1658	Rainbow - AltaGas	5,290.9	179.6	96.6%	95.9%	5,052.1
17	1506	Progress - CNRL	11,434.5	318.2	97.2%	96.5%	11,040.4
18	1147	Sinclair (Hythe Brainard) - EnCana	35,788.5	422.8	98.8%	98.3%	35,027.5
19	1134	Quirk Ck. - Imperial	99,625.5	1,200.6	98.8%	98.3%	97,571.4
20	1892	LaGlace (Saddle Hills) - EnCana	118,396.4	1,615.0	98.6%	98.4%	116,971.1
21	1482	Brazeau R. - Blaze	134,270.5	1,399.8	99.0%	98.4%	133,543.5
	Totals		**2,423,797.3**	**15,509.38**	**99.3%**		**2,365,450.84**
		Grand totals	**5,319,910.8**	**56,618.1**	**98.9%**		**5,182,703.4**

Appendix 5. Sulphur Credits Earned

		Grandfathered sulphur recovery gas plants	Credits				Cumulative Credits				Status
			Jan-Mar 2006	Apr-Jun 2006	Jul-Sep 2006	Oct-Dec 2006	Jan-Mar 2006	Apr-Jun 2006	Jul-Sep 2006	Oct-Dec 2006	
	Plant Code										
1	1108	Brazeau R. - Keyera					-	-	-	-	Degrandfathered
2	1121	Brazeau R. (Nordegg) - Keyera	-3.1	12.4	18.9	9.8	597.1	609.5	628.4	638.2	
3	1131	Burnt Timber - Shell	-31.5	-82.8	17.6	45.5	949.2	866.4	883.9	929.4	
4	1374	Caroline (North) 1-11 - BP Canada					-	-	-	-	Plant shut down
5	1104	Caroline (South) 4-20 - BP Canada					-	-	-	-	Plant shut down
6	1020	Carstairs - Bonavista	-1.3	7.2	6.8	1.0	220.1	227.3	234.2	235.2	
7	1050	Crossfield (Balzac) - Nexen	56.4	0.0	0.0	28.0	1,804.3	1,804.3	1,804.3	1,832.3	
8	1084	Edson - Talisman					122.2	122.2	122.2	122.2	Degrandfathered
9	1129	Gold Creek - CNRL	10.4	5.3	2.5	12.0	175.7	181.0	183.5	195.5	
10	1037	Jumping Pound - Shell	481.9	488.5	546.2	592.5	3,891.4	4,379.9	4,926.1	5,518.6	
11	1107	Kaybob S. 1 & 2 - Cams Midstream Services	119.3	86.9	-39.5	129.0	2,836.1	2,923.0	2,883.5	3,012.5	
12	1144	Kaybob S. 3 - Semcams	239.5	149.9			3,064.0	3,213.9	3,213.9	3,213.9	Degrandfathered
13	1139	Lone Pine Ck. - ExxonMobil	13.3	0.0	9.5	13.2	234.4	234.4	243.9	257.0	
14	1047	Minnehik B. L. - Penn West	3.4	2.3	3.1	5.2	79.0	81.3	84.4	89.7	
15	1530	Okotoks - MPP					-	-	-	-	Degrandfathered
16	1028	Redwater - Imperial	30.3	35.4	14.6	29.2	283.3	318.8	333.4	362.6	Variable inlet rate
17	1206	Rosevear (North) - Suncor[1]					-	-	-	-	Plant shut down
18	1268	Rosevear (South) - Suncor[1]	39.2	15.0	12.1	25.4	1,577.5	1,592.5	1,604.6	1,630.0	
19	1113	Simonette - Suncor					663.7	663.7	663.7	663.7	Degrandfathered
20	1141	Strachan (Ram River) - Husky	318.8	304.5	435.6	503.1	26,048.2	26,352.7	26,788.3	27,291.3	
21	1133	Strachan - Keyera					1,229.7	1,229.7	1,229.7	1,229.7	Degrandfathered
22	1112	Sturgeon Lk. - Kereco					590.6	590.6	590.6	590.6	Degrandfathered
23	1296	Teepee - Talisman	40.4	38.0	34.5	32.1	651.2	689.2	723.7	755.8	
24	1056	Waterton - Shell	248.1	267.4	138.8	1,057.4	7,512.0	7,779.4	7,918.2	8,975.6	
25	1054	Wildcat Hills - Petro-Canada	103.7	119.6	130.9	132.5	1,908.0	2,027.6	2,158.4	2,290.9	
26	1081	Wimborne - Vault	59.8	73.2	44.8	77.2	1,525.3	1,598.5	1,643.2	1,720.5	
27	1034	Windfall (West Whitecourt) - Semcams	136.5	154.7	162.2	137.0	4,341.7	4,496.5	4,658.6	4,795.6	
28	1219	Zama - Apache[2]	31.1				1,011.7	1,011.7	1,011.7	1,011.7	Delivers acid gas to its Apache Zama AGI plant as of October 2004
		Totals	**1,896.11**	**1,677.57**	**1,538.44**	**2,830.07**	**61,316.4**	**62,994.0**	**64,532.4**	**67,362.5**	

[1] Plant consolidation.

[2] Apache Zama - shipping acid gas to adjacent AGI gas plant.